WHITE PAPER

THE INTEGRATED DATA ENVIRONMENT

CONTINUOUS ACQUISITION AND LIFECYCLE SUPPORT

15 October, 1996

EXECUTIVE SUMMARY

CALS VISION

The CALS vision calls for the deployment of the Integrated Data Environment (IDE) concept into the defense acquisition and sustainment environments as summarized in the following:

> *The armed forces of the United States operate in an information rich electronic environment that integrates technical and tactical information. Technologies and doctrine are rapidly developed and employed. Readiness and warfighting capabilities are continuously improved to maintain our superiority over a potential adversary. We provide and <u>integrated data environment</u> and <u>the implementing processes</u> for the people who design, acquire, use and support weapon systems. This gives them the technical and management information needed to field, operate, and sustain affordable, effective weapon systems and to achieve major reductions in process cycle times. Ready access to accurate acquisition and logistics information improves lifecycle management, enabling mission performance at lower cost. The integrated data environment is further characterized by: broad based multi-functional industry and government teams, use of international standards throughout the product lifecycle, use of an international information highway to provide access to integrated data throughout the global industrial base, flexibility to grow with and adapt to user information needs and appropriate levels of security.*
>
> *And…accomplish this with a 50% reduction in weapon systems acquisition cycle time.*

Note: The CALS vision statement above was developed and agreed upon during the DoD CALS Strategic Planning Conference held in Charleston, SC on 7-9 March, 1994.

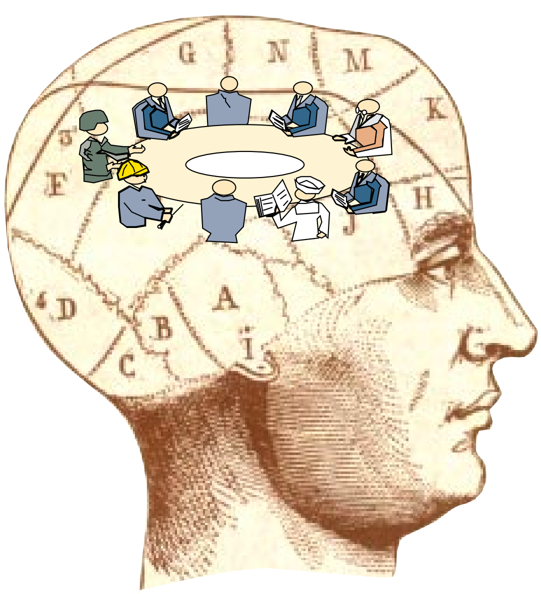
OBJECTIVES

The objectives of the OSD CALS Office are to:

- Deploy progressively more capable IDE solutions to defense system acquisition and sustainment program environments in a manner consistent with the acquisition strategy and sustainment plans
- Support the evolution of Integrated Product Teams (IPT) to Agile Product Teams (APT) and, ultimately, the Virtual Product Teams (VPT) through an continuing evolution of IDE definition that provides a progressively increasing capacity to access accurate, high quality, and timely product information
- Advance the technological state of the IDE to insure compatibility with and maximize leverage of emerging open network based information transfer and management standards while improving the economic benefit to the user.
- Apply the IDE to achieve increasingly collaborative and agile modes of operation within the defense acquisition and sustainment enterprise; i.e., make it operate as a Virtual Enterprise.

IDE DEFINITION

DoD's overarching goal in CALS is to develop a seamless defense enterprise in which the knowledge products of acquisition and sustainment processes are immediately and rapidly accessible to all authorized users when needed while maintaining near immediate currency and quality of information. This collaborative information principium is called the Integrated Data Environment (IDE). The IDE represents the fulfillment of the CALS vision in which defense system engineering and business information is readily available to all Integrated Product Team (IPT) members engaged in life cycle process execution. High quality, timely life cycle information is generally available at its source of generation (usually the owner of the associated engineering or business process) in digital form. The IDE concept includes interactive computer-aided configuration management (ICACM) procedures that ensure the high "precision" of requests for information and the subsequent response by process owners. Widespread use of such source data by government and commercial organizations on an as needed basis transforms data from an overhead cost



The IDE Is a Mindset for Collaboration Through Shared Information

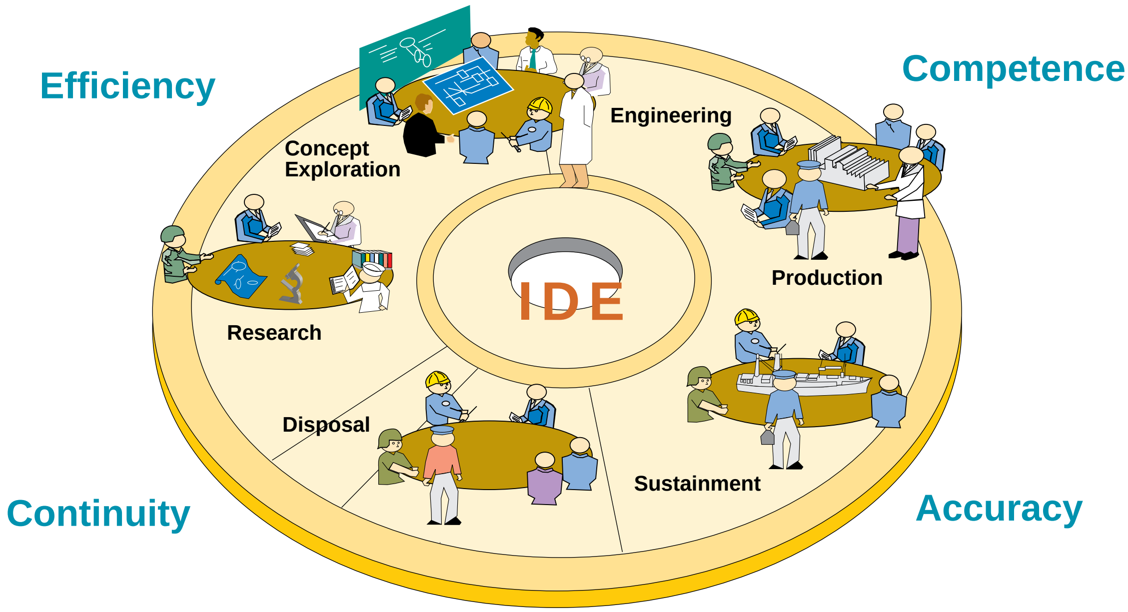
item to an enterprise asset thereby strongly motivating its owner to maintain its currency and accuracy

The IDE precept transforms the IPT into an Agile Product Team (APT). In an APT/IDE environment, interactive workprocess management (WPM) software is used to manage team activities in a manner that maximizes concurrency of team decisions and other actions. By ensuring that the interactions necessary to arrive at a truly collaborative decision take place – even among a geographically separated team – WPM integrated with ICACM converts a large, multifaceted, otherwise unwieldy, committee into a tightly knit team performing at the level of collaboration previously found only in small, compact organizations. The IDE concept ultimately enables the APT to access intellectual resources well beyond its original scope on an as needed basis. Through the informational connectivity provided by the IDE, national subject matter specialists (such as failure analysts) can be made an interactive part of the team, but only during the time their contribution is needed and at an incremental cost that would be a fraction of the cost of full term participation. In fact, specific participation by the specialist may not be required. His/her services may be rendered through leased access to specific information items or specialized application tool sets. This Virtual Product Team (VPT) – an agile team augmented by intermittent timely contribution from specialized intellectual resources – represents the end state envisioned by the IDE.

A communications and information management infrastructure provides the conduit in which the information flows from source to authorized user. Within the government community, infrastructure services that support the IDE will be provided by the emerging Defense Information Infrastructure (DII). The National Information Infrastructure (NII) should provide comparable capability to commercial participants. In addition, functional information management services and other implementing processes are offered via the infrastructure on an as requested basis. The infrastructure, together with users and providers of information comprise the equivalent of a massive distributed data base network facilitating streamlined concurrent engineering of products and processes, along with more efficient acquisition and sustainment.

Practical IDE solutions are currently being deployed on a site by site basis as manifested through the confluence of existing assets, including the Joint Computer-Aided Acquisition and Logistic Support (JCALS) system, the Joint Engineering Drawing Management and Information Control System (JEDMICS) and the Configuration Management Information System (CMIS). Near future solutions will exhibit greater agility, being supported by the DISA's Common Operating Environment (COE) and Shared Data Environment (SHADE). However, COE/SHADE by themselves are not fully compatible with the complete universality implied by the IDE. Ultimately, the IDE is a functional requirement for a wide scale (international) mixed computing and communications environment to transact in heterogeneous data using open networking middleware packages that can not be prespecified. This is in contrast to the heterogeneous computing environment, common middleware, and standardized data elements required by COE/SHADE. Functional and data standards will provide the operating link between the converging manifestations of the DII — GCCS/GCSS — and more divergent NII and international equivalents.

While an IDE solution is hosted by a specific infrastructure, the IDE is in reality the product of participation by its users: defense system program offices; government, commercial, and academic laboratories, industrial facilities; prime contractors; sub-contractors; component vendors; small manufacturing enterprises (SMEs); manufacturing centers; and, lifecycle technical service providers. Lacking a static system configuration, data “owners” use the IDE to maintain configuration control of data, data sources, and service providers through constructs embedded in data.



IDE Enhances Team Collaboration Across Weapon Sysem Life Cycle

Thus, the IDE represents a state where its users have ready access to a massive distributed common information ***object*** base.

BENEFIT

The CALS initiative has developed a number of tools to facilitate the transition from a paper-intensive to a paperless and automated mode of operation, including: data standards, infrastructure components, and interface performance standards. Until recently, these elements have not been integrated into a comprehensive solution available for deployment by defense system program managers. In addition, they do not reflect extensive functional process reengineering to capture the full range of benefits which CALS enables. The IDE represents a true departure from this tradition by breaking the dependency cycle of highly configured physical information deliverables. Information is available in a “configuration neutral” shared information framework. The benefits that will be realized through such reengineering are impressive.

IDE implementation enables the infrastructure focus to shift from systems to applications. This environment will facilitate more efficient functional processes wherein data requirements are met through flexible applications running on a global infrastructure (NII/DII) with basic services in place that provide the core functionality associated with supporting the weapon system life cycle. The need for custom information systems (vice relocatible applications) development and "reinventing the wheel" will be significantly reduced.

IDE delineation of logical and legacy dependencies of data on a real time basis tends to reduce the plethora of duplicate, synchronous (or often asynchronous) data that exists in today's stovepipe systems. Data accuracy will improve and users will be able to access logically related data via a single conduit. Removal of sources of data ambiguity will enable concurrent engineering in a highly distributed environment. Competition for products and services will be enhanced throughout the acquisition and sustainment life cycle.

The IDE enables APTs and VPTs. The IPT concept, although largely hailed as a stunning success in the field, is fundamentally constrained without the ability to transcend geographical and organizational boundaries. Information access must be timely to the team decision or action under consideration, or the team member(s) lacking such information are excluded from meaningful input to the decision, putting collaboration at risk. An increasingly capable IDE following advances in open networking technology is an absolute necessity to APT and VPT success.

IDE use facilitates continuing process improvement. Because the infrastructure focus is shifted from systems to applications, functional business process improvements are much less encumbered by systems driven limitations. Workprocess management software provides the repeatability and predictability of action processes necessary to baseline and economically justify substantial reengineering. Functional practices drive the supporting information environment rather than vice versa.

IDE enables many Acquisition Reform strategies. Privatization and outsourcing, contractor logistic support, and other strategies for improving acquisition and sustainment processes at lower cost all depend upon the ability to access and exchange accurate engineering and business data with high precision. Their success is dependent on the ability of the IDE to evolve from a site by site solution to a global solution that is seamless and universal throughout the defense enterprise.

THE INTEGRATED DATA ENVIRONMENT

I. IDE DESCRIPTION

The purpose of the IDE is to effect improvements in the operation of the DoD enterprise. Initial emphasis is being placed on weapon system acquisition and logistic support business processes. Its objective is to enable the use of teams (IPTs) and collaborative decision-making in acquisition and logistic business processes to reduce costs, shorten cycle times, improve readiness, and enhance the quality of decision making associated with these processes. The IDE recognizes that the ability to share information in a meaningful way – the right information at the right place at the right time to effect an informed collaborative decision or action — is essential to these highly desired process improvements.

The IDE is anchored by a set of three essential cornerstones that enable collaborative business processes and the effective use of integrated teams throughout a product's life cycle:

- Information sharing
- Configuration Management, and
- Workprocess Management

The IDE is fundamentally defined by these cornerstones and associated operating principles rather than a discrete hardware/software set or operating environment. However, the way in which these functional concepts are translated to practical solutions is crucial to the achieving a real IDE that approximates the notional IDE. The key to understanding how this is best achieved lies in understanding the implications of two competing (and seemingly incompatible) requirements under the IDE concept: universality and interoperability.

Universality implies the ability to deal with a highly heterogeneous computing and information environment to accommodate diversity. Interoperability tends to imply standardization which by definition constrains diversity. It is essential that long term IDE solutions optimize the focal points of universality and interoperability. Initial IDE solutions are heavily weighted in favor of a standard system approach through the use of standard DoD systems (JCALS, JEDMICS, CMIS) but at a cost of the solution sets being localized to a limited locus of government organizations closely connected topically. Later solutions must evolve from a standard systems approach to a more judicious use of information standards that maintain interoperability but at minimal expense to universality. The question is where to apply the standards to achieve an effective balance. The following analogy is designed to provide an understanding of the IDE implementation concept:

Looking at information sharing first, if one uses a railroad to represent information transfer within the enterprise of interest, the network of tracks that connect the various providers and consumers is analogous to the network middleware that DISA will specify for DoD through COE and SHADE. The railroad cars and locomotives equate to the infrastructure - hardware, operating systems and applications that will move freight (information) between users via the network of tracks. The commodities transported on the railroad are equivalent to the information exchanged in the defense enterprise.

It is of particular interest to note which components of the railroad must be homogeneous (interoperability focal points) and which can be heterogeneous (universality focal points). The only area requiring absolute homogeneity is the track at the form, fit and function level (i.e., those infrastructure specifications driven by the track). The rails are all 42 inches apart, 6 inches high and 3 inches wide. Note that a lack of track homogeneity in Europe has been a traditional barrier to more efficient commerce there. Freight cannot be efficiently moved from production to user without laborious interface actions. In an optimized railroad, the cars and locomotives are designed to run on a single track specification, but are a heterogeneous mixture of types, shapes, designs and are produced by multiple manufacturers. The cargo transported is even more diverse, and is standardized only in the grossest form such that it will fit on the train. Translated to our defense information environment, this says that we need a standard interface specification to the middleware that links the members of the environment, but need not be rigid in standardization across the infrastructure (other than it must interface with the middleware). Information (data) is almost completely heterogeneous and is driven by the providers and consumers provided it is packaged in containers that make it compatible with the rolling stock that moves it; i.e., it is packaged into objects. The optimal railroad (infrastructure and middleware) will transport non-standardized information between any provider and user.

While the analogy above is simplistic, it is necessary to explain the purposeful focus of standardization at the middleware (or interface) level. While middleware standardization may seem to be a subtle implementation detail of interest only to the technologist, it is fundamental to the IDE concept. Equally fundamental is the purposeful design of an environment that will accommodate non-standard infrastructure and data. It is through this minimally standardized approach that the environment gains agility and the capability to support continual change in both infrastructure, applications and data.

While the requirement for universality places considerable autonomy of participation in the IDE (producers and consumers are free to agree to the timing and frequency of shipments without regard to railroad system architecture), some self control mechanisms are required to ensure that the information flow is correct and timely to the problem at hand. Configuration management and workprocess management are the conceptual constructs that relate to the functional environment just as information sharing relates to the technical environment.

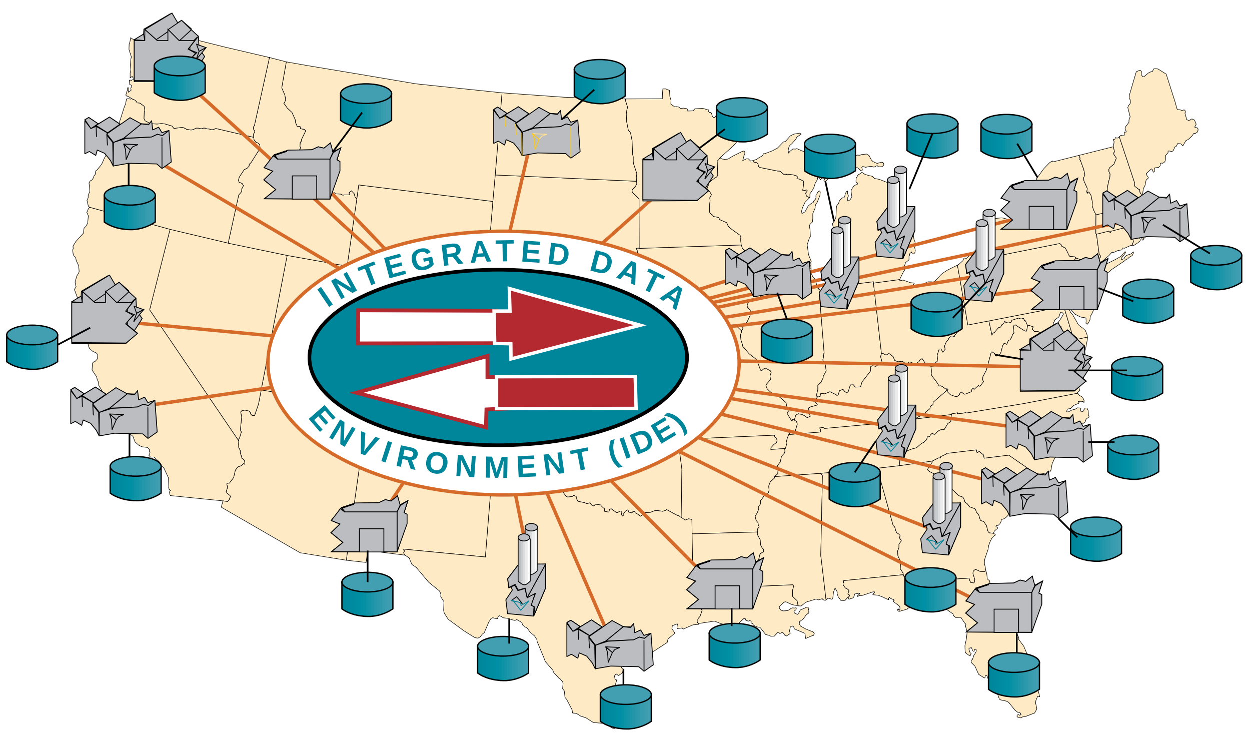
The CALS Office, in the form of the IDE specification, will provide a configuration management standard specifically tailored to effect and support a team-based acquisition and logistic support business process approach working in an information sharing environment. This standard will be an evolutionary change from the existing set of configuration management standards, however changes in the way configuration data is acquired and maintained are likely to be significant.

A workprocess management standard will also be developed. This standard will address the fundamental process workflows involved in acquiring and providing logistic support to weapon systems in a team based environment. Specific emphasis will be placed upon identifying the information flows among team members and among the various teams that are involved in these processes across the weapon system lifecycle. Process workflows developed in accordance with this standard will provide the functional guidance to weapon system teams that specifies the work items that must be accomplished during each phase of the life cycle. These workflows will be coordinated with the information sharing and configuration management activities such that the information required to complete work items is readily available to the team members involved.

The IDE then is a set of precepts designed to effect tangible business process improvements (cost savings, cycle time reductions, etc.) through enabling a team based organization approach to acquiring and supporting weapon systems. The precepts sort to three fundamental areas - information sharing, configuration management, and workflow management. The CALS Office will develop standards in all three areas.

CONCEPT OF OPERATIONS

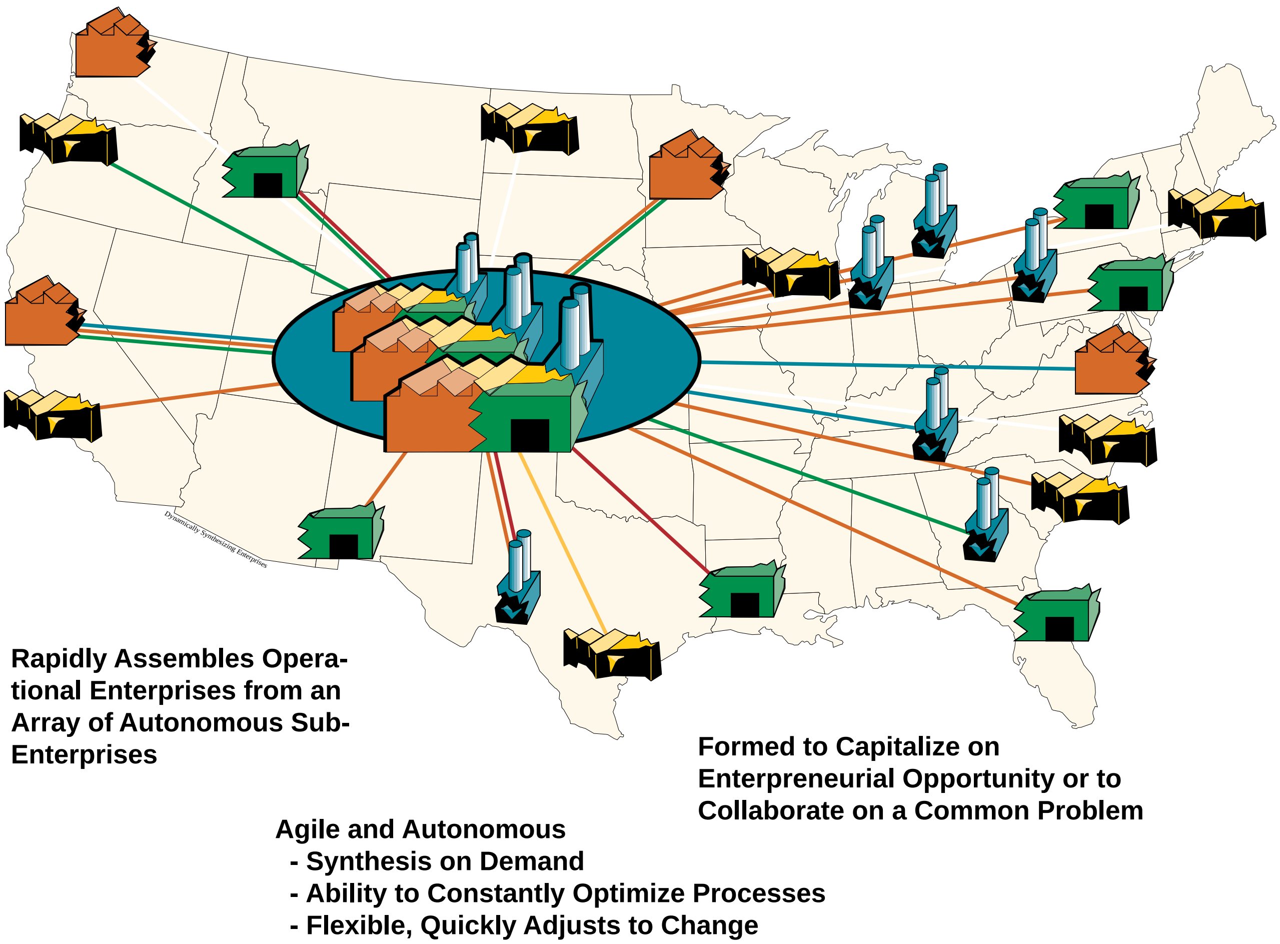
DoD's concept of operations for the IDE is shown below. Defense contractors, subcontractors, and suppliers deliver product information in place in accordance with industry developed application packages. Until the application packages are developed, current practices can



be used as guidelines. Program offices, depots and field activities access the information on demand, paying a minor fee per access as opposed to a one time purchase of a configured physical item or file. This creates an environment of information merchandising among participants in the enterprise. This new commodity nature of information will motivate the expenditure of resources to maintain its currency and quality. The information marketplace environment may also serve to overcome current issues regarding access to “private information” by reducing information access to a straightforward business decision. Third party service vendors will provide support and analysis functions (such as test program generation or reliability analysis) by accessing and processing information from the original source. As comparable commercial applications of the IDE mature, dual use of commercial products becomes viable and likely. In addition applications are no longer tied to a specific site or data set. Application mobility and relocation can finally be achieved.

II THE VIRTUAL ENTERPRISE

Translation of the information sharing premise out of engineering or manufacturing into the boardroom (business operations and strategies) results in a philosophy and practice commonly called a *virtual enterprise* (VE). A virtual enterprise is a cohesive, but potentially continuously



adapting, business entity made up of diverse subentities. What distinguishes a VE from other multi-participant endeavors, such as a collaborative joint venture, is the diversity of business rules that may be found among the subentities that comprise a virtual enterprise. In a typical joint venture, a set of common business rules is established for the joint venture. Participants in the joint venture must adopt to the common business rules which often means isolating the group supporting the joint venture from other participant business operations. Due to this fact, a joint venture tends to be static: its relationships among participants tightly coupled and entered into or withdrawn from with great deliberation and difficulty. Thus, the joint venture tends to be targeted toward a limited, finite business purpose with little intention of adapting to changing business environments or markets. On the other hand, the ideal VE is loosely coupled. Without the need to accommodate a new set of business rules, participants can opt in or out of the VE at will; it is inherently agile. It is also information intensive. Widespread information sharing is required to transcend the diversity of business rules and methods that may be encountered when operating a VE.

VIRTUAL VERSUS CONVENTIONAL ENTERPRISES

While a great deal of attention has been directed at the "virtual" content in the term: VE, the key to understanding the concept lies in the "enterprise" content. The enterprise in virtual enterprise refers to a specific business goal or objective that stays constant while the structural aspects of the business may constantly change. This is in contrast to the common usage of the term "enterprise" where in the organizational structure remains constant while goals and objectives may constantly change. In other words, in conventional thinking, the enterprise becomes synonymous with its relatively static business processes and organizational hierarchy. For example, GM has come to refer primarily to the physical plant, the people and the organizational structure engaged in producing certain automobiles. In a VE, the enterprise is not the organization; it is the greater business goal constant under which organization is the variable. VE business goals may be as diverse as:

- creation of wealth through the development, production and sale of a product to satisfy a particular need for a limited time frame; e.g., manufacture of custom flags for sale at the Olympics
- creation of wealth through the development, production and sales of a product line over an indefinite period of time; e.g., a line of custom high performance bicycles
- sustainment of a class of military systems through the provision of the goods and services needed over an indefinite time; i.e., depot privatization
- utilization of a government owned capital resource by private contractors to create wealth and service government products; i.e., outsourcing and dual use.

FORMAL DEFINITION

A virtual enterprise may be defined as a continuously operable, *directed business venture* based on the mutual collaboration of an array of potentially changing, independently operated component business entities The assembled entities retain their separate corporate identities while forming a distinct new entity: the virtual enterprise. The component entities need not be collocated and may (or may not) be a portion of the same parent organization. Furthermore:

While extensive collaboration among the component entities (participants) is required to establish and operate the directed business venture, the participants retain independence of organizational form **and** business rules and methods. Participants may or may not:
Participate in multiple Virtual Enterprises;

- Assume different roles in different Virtual Enterprises;
- Change their role within the lifetime of a Virtual Enterprise;
- Maintain a conventional product or service while participating in Virtual Enterprises without disrupting their rules and methods or the distinct business rules and methods of the Virtual Enterprises they participate in.

The purpose of the directed business venture is to pursue a clearly defined operational goal that includes a bounded range of products or services. The goal's statement also formally bounds the rights and responsibilities of the participants in the business venture. The products or services may or may not:

- Compete with similar products or services offered by the participants;
- Be fully specified in advance;
- Be individually configured or customized;
- Have markets at the time of formation of the Virtual Enterprise.

VIRTUAL ENTERPRISE EXAMPLE

For example, a virtual enterprise formed to produce and market a new type of automobile may initially consist of the design staff at Chrysler, the production facilities at GM, and Ford's marketing and sales organization. Each company (or division) participating in the new enterprise continues to exist in its own right: designing, producing and selling its own vehicles while participating in the VE. However, the new car's design, production and sales team becomes a distinct commercial enterprise with its own business processes, practices and goals while its participants maintain their corporate identities and business rules. Team members readily transition from internal operations to the virtual enterprise as required. In time, as the new product line becomes popular, additional production facilities at either Chrysler, Ford, GM, or Toyota and BMW are brought into the VE. Additional design or sales assets are made available or let go as the market dictates. If at a time, the VE fails to meet its business goals, it can be terminated.

VE RELEVANCE

The Department of Defense has historically operated as a conventional monolithic enterprise consisting of: its fielded forces; its internal organic resources, such as laboratories, depots, and engineering activities; and its contractor and supplier base. Traditionally, the DoD has operated under an internally consistent organizational structure and set of business rules which it also imposed on its vendor base as a condition of doing defense business. To a large extent, this massive hierarchical structure has become synonymous with the DoD and its activities. This business approach worked satisfactorily in the cold war era, during which the threat and operational and business environments were relatively static. However, the post cold war global situation requires the ability to rapidly adapt to changing threats and environments while dramatically reducing the cost of defense. One generally accepted tenet of this shift in perspective is that the monolithic top-down structure of the “military/industrial complex” is no longer technically or financially viable.

Downsizing, streamlining, privatization, inventory reduction and outsourcing are all being advanced as valid structural concepts to deal with these dramatically changing defense ground rules. Cycle time reduction and life cycle cost reduction are being pursued as companion operational concepts. They all challenge DoD's traditional organizational premises. For example, depot privatization, associated with greater prime contractor responsibility for weapon system support will likely increase the number of organizations, government and industry, that will participate in the support of a weapon system across its life cycle. This effect will likely dramatically increase if depots are privatized on a shop by shop basis and increase even further if the shop privatization contracts are routinely recompeted. One alternative for managing this contractor array is for the DoD to impose the full extent of its business rules on all members of the array. However, this would only result in a highly complex Government Owned-Contractor Operated (GOCO) situation that would likely be no more productive than previous GOCO enterprises (and could prove to be much less). An alternative is to apply a virtual enterprise approach since one of the defining characteristics of the VE is its ability to manage operational diversity among its members.

VE CONSIDERATIONS

EMPOWERED TEAMS Virtual enterprises are generally recognized to employ empowered teams as a program management and execution approach while the role of teams in relation to the traditional organizational structure remains poorly defined and frequently debated. Empowered teams such as IPTs are generally recognized as the new wave of process productivity and their impacts in a short time span have proved impressive. However, most often they are new appendages to the traditional functionally oriented organization rather its successor. In some cases, the team is overlaid as another layer of management to the traditional functional hierarchy. In others, it is regarded as just another functional "player". The team concept is central to VE initiation and operation definitionally because the VE crosses the organizational boundaries of diverse business rules.

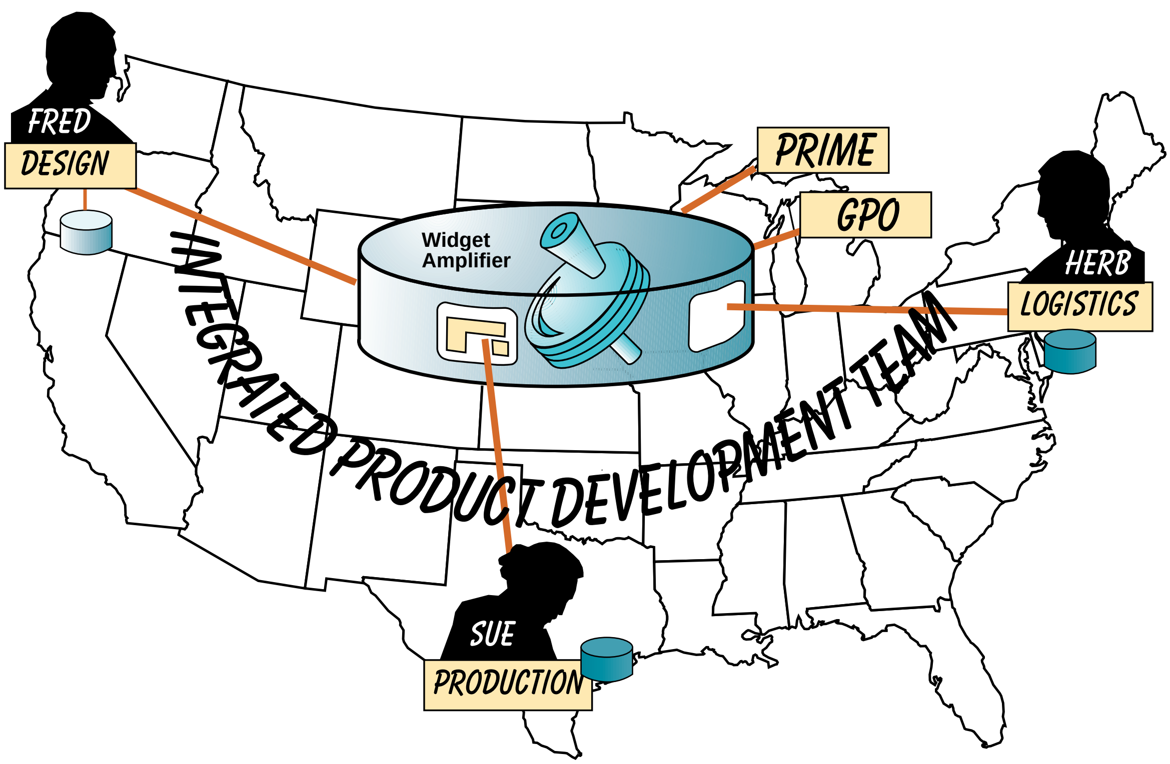
ELECTRONIC MARKETPLACE Virtual enterprises will tend to thrive in, and at the same time reinforce, a vigorous marketplace of process "services". These services, — materials, fabrication and assembly, testing, engineering and analysis — especially when made available quickly through electronic means, such as electronic commerce, tend to decompose traditional enterprises as functions can be reliably outsourced. The expansion of an electronic *enterprise services marketspace* further encourages virtual enterprise formation because VE entrepreneurs have the confidence to initiate virtual enterprises even though all participants may not be readily identified up front.

INFORMATION INTENSITY Virtual enterprises require a generic and specific environment of intensive information sharing to succeed. The generic environment must provide the basis for the rapid exchange of information relevant to the assignment of work to segments of the enterprise. This function is normally thought of as the business function of contract bidding, placement, and payment, and its data to be business data. However, business data must be merged with substantial technical information so that an informed work assignment can be made. Once work assignments are made and collaborative work begins, specific product and process engineering information must be rapidly and confidently shared.

III Team Collaboration In Action — IDE Scenarios

Scenario 1

A design engineer (Fred) is a member of an integrated product development team developing the preliminary design of a weapon system sub-component — the widget amplifier. His team consists of a logistics specialist (Herb) charged to design the life-cycle characteristics of the product, a production engineer (Sue) charged to ensure the producibility of the product, and himself, the design engineer charged to meet performance specifications. Each team member is located in a different region of the country, but because the team is working in an IDE environment, each team member has full access to all of the relevant information concerning the widget amplifier. The team works concurrently and in real time. Applications supporting each function are run off a virtually common shared data environment.



Scenario 1.

Only this morning, the aircraft prime contractor notified Fred that the dimensions of the widget amplifier would have to be modified to conform to a revised avionics bay design. Fred signed on to the system, pulled up his design model, and rearranged some of the components so that the amplifier would fit into the revised space allowance.

As Fred was running his vibration analysis subroutine on the revised design, Herb signed on and was alerted to the redesign. Herb immediately started a fresh BOM (Bill of Materials) analysis, with its associated outfitting sub-routine, using Fred's design model data directly. Herb's analysis showed that outfitting would have to be increased significantly because Fred had introduced several new components in order to reduce the size of the package. He annotated Fred's design to indicate the components that were principal drivers of the increase in outfitting requirements, and asked Fred if common components from other areas of the design could be substituted for the new parts.

Sue signed on shortly after Herb sent his comments back to Fred. She decided to run her MRP IV (Materiel Return Program) routine against the revised design model to examine the impact on work-loading and workflow management on the shop floor. Her analysis revealed that the number of boards requiring wave flow soldering was doubled, and since the projected work load at the soldering lines was already heavy, production time and costs would increase by 15%. She fed this information back to Fred, and asked if he could reduce the number of individual circuit boards.

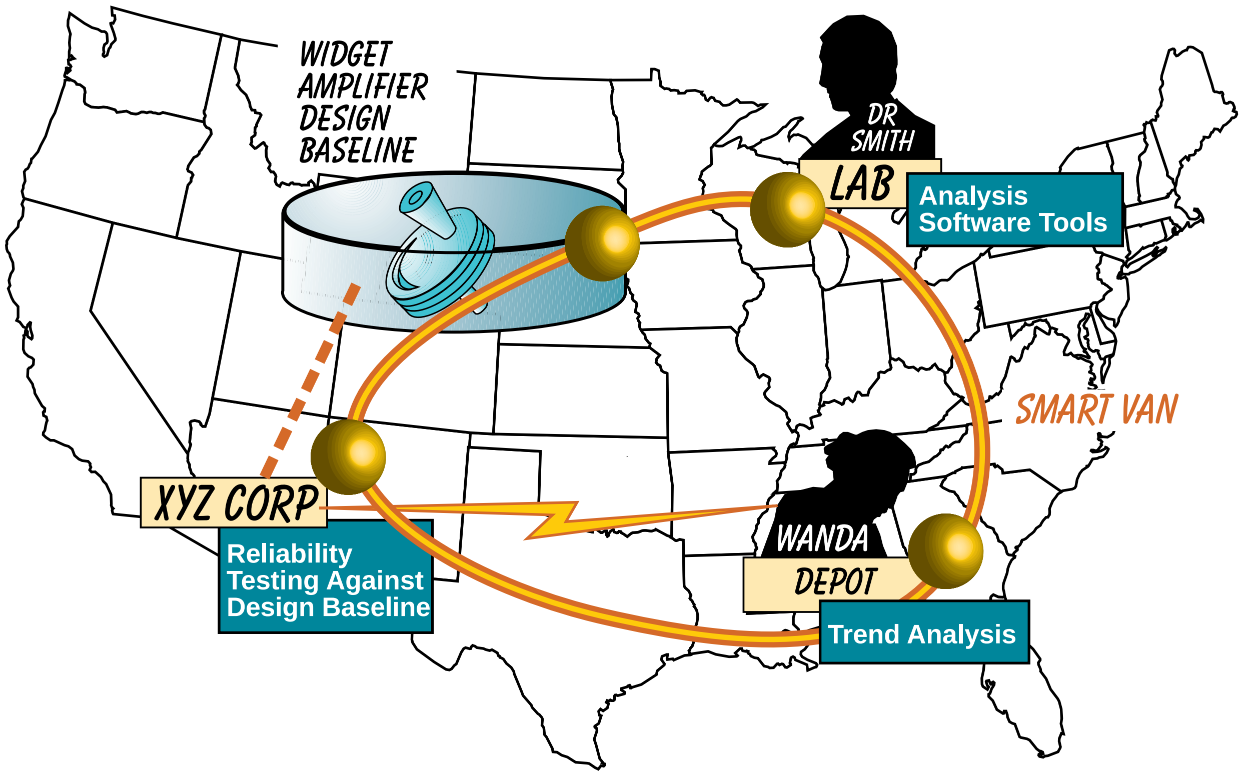
Fortunately for Fred, Herb's comments about using common components triggered a thought that he had considered earlier in his design deliberations. By making only a minor change, he could use the same chip throughout the multichannel preamp. He could eliminate most of the new components in his original redesign and they could all be mounted on a single circuit board. Fred revised the design model to reflect his new idea. Both Herb and Sue quickly responded that the new redesign appeared to avert the problems. The redesign was passed to the government program office (via the IDE) as an integrated package for program office approval. The government program office approved the change and noted same on the package, thereby providing all IDE users with a government approved widget amplifier design package.

While the above scenario may be simplistic, the intent is to illustrate an environment wherein the design process can truly be performed in a concurrent fashion. Because all members of the design team are working from a common information infrastructure, cross-functional information flow is seamless. Multiple applications, e.g. design modeling, MRP packages, BOM packages, are all using an integrated data infrastructure, and all are operating under a common framework. Series processes and the inherent delay associated with reviews and re-reviews are avoided, and the design process becomes much more efficient.

Scenario 2

It is now five years later and the widget amplifier is experiencing unexpected failure rates in the field. Wanda, an engineer at the depot, has reviewed the design data and determined that the component which appears to be causing the failure was supplied by XYZ Inc. Though the performance specifications appear to be adequate to meet the design requirements, the component in question is not meeting Mean Time Between Failures (MTBF) projections. She contacts XYZ Inc. and asks if they have any data that will explain the recent series of failures.

As the assigned in-service engineer for widget amplifiers, Wanda controls access to widget amplifier tech information. She wants to provide XYZ engineers with access to the design baseline held on the IDE for their use in technical analysis. She notes that all rights to the widget amplifier tech data were purchased by the government as part of the acquisition process and that no classified information is involved, and then makes the necessary notation to permit XYZ access to the widget amplifier technical data. (Had proprietary data rights or classified information been involved, additional access approval steps would have been necessary).



Scenario 2.

After being authorized access, XYZ engineers subject the design baseline model stored at the depot to their in-house reliability analysis software tools and compare the results to the field failure data. They contact Wanda to advise her they suspect the failures are due to magnetic surges the widget amplifier is subjected to because of its location next to the framus coil. XYZ has experienced similar failures of that component in other applications subjected to magnetic anomalies. Their recent test of a similar product under similar circumstances showed unusually high failure rates. The engineering analysis of their test is available on line and can be procured through the IDE Smart Value Added Network (Smart VAN). XYZ has developed a substitute component that should be available sometime next year, but because it is a custom design, the new price will be extremely high.

Wanda knows the operating forces will not tolerate failing widget amplifiers for another year and she does not desire to pay the higher price of the substitute component. She knows the Air Force lab has been examining magnetic influences on electronic components and decides to seek their assistance. She contacts Dr. Smith and asks that he review the situation.

Assembling the original design data, the failure information, and XYZ’s analysis through the Smart VAN, Dr. Smith applies his internally developed magnetic analysis software tools. He detects a phenomena that he recently encountered in a similar situation. Smith calls Wanda and says, based upon prior experimentation, it seems likely that coating the component in question with a nonconductive paint should solve the problem. Wanda authorizes a quick turn-around test program to confirm the hypothesis and one month later is able to issue a service bulletin that solves the widget amplifier failure problems.

Once again the scenario is simplistic, but the message is that with seamless access to information, e.g., historic design, current failure data, reimbursable vendor input, and R&D, operational problems can be dispatched in an efficient manner. The time typically wasted in finding and assembling data is avoided, and the circles in which information is shared are broadened.

Scenario 3

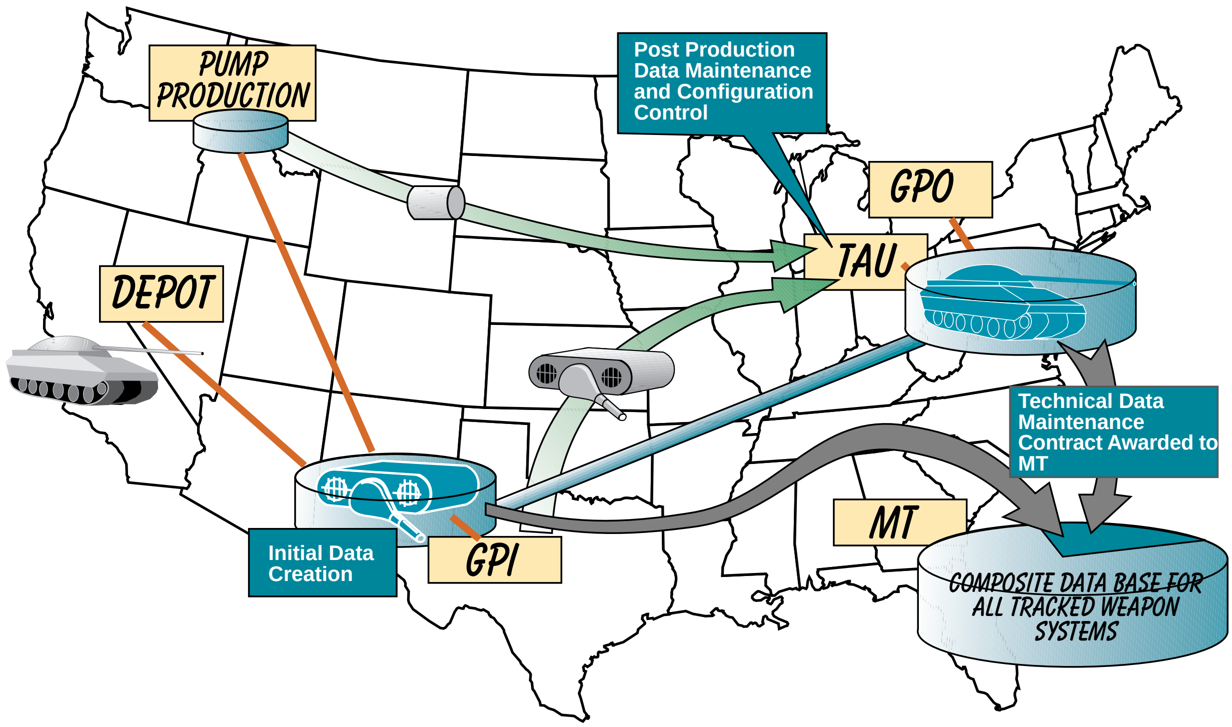
Generous Propulsion, Inc. (GPI) has been contracted to Tanks Are Us, Inc. (TAU) to provide engines and power trains for the next generation main battle tank being built for the U.S. Army. As part of the contract, GPI will control and maintain technical data for the engines and power train throughout the design, production, and testing phase of the life-cycle.

During Low Rate Initial Production (LRIP) and as a result of live fire testing, the government has determined that the engine oil sump pump, although it complies with the original government contract requirements, is vulnerable to damage from land mines. The government directs TAU to increase the shock hardening of the pump by 50%. With the full rate production contract this change must be implemented quickly to avoid costly rework later in the field.

TAU engineers immediately analyze the sump pump engineering data (maintained in the IDE by GPI) and determine the pump complies with original design specifications. They set up an on-line design conference with the GPI engineers to mutually establish revised performance parameters and redesign the pump. Several areas of the pump design are beefed up to provide additional hardness. Finite element analysis at GPI is supported by near simultaneous application analysis at TAU to provide a high level of confidence in the validity of the fix.

Meanwhile the government program manager has assigned testing responsibility to the depot. Government engineers there also access GPI’s design and analysis data to review the current design, failure modes during testing, and the prototype design of the hardened pump. They develop a new test procedure and review it on-line with GPI and TAU. This takes place in parallel with production of six prototype pumps at an agile manufacturing facility. The prototypes are tested immediately upon delivery and found to meet the new requirements. GPI revises the technical data configuration records, and the tank goes into service without further incident.

As the GPI produces the last of its production run of engines and power trains, responsibility for maintaining technical data for the entire tank is transitioned to TAU. TAU will provide data maintenance and configuration control services for tanks still in production and also in-service tanks.



Scenario 3.

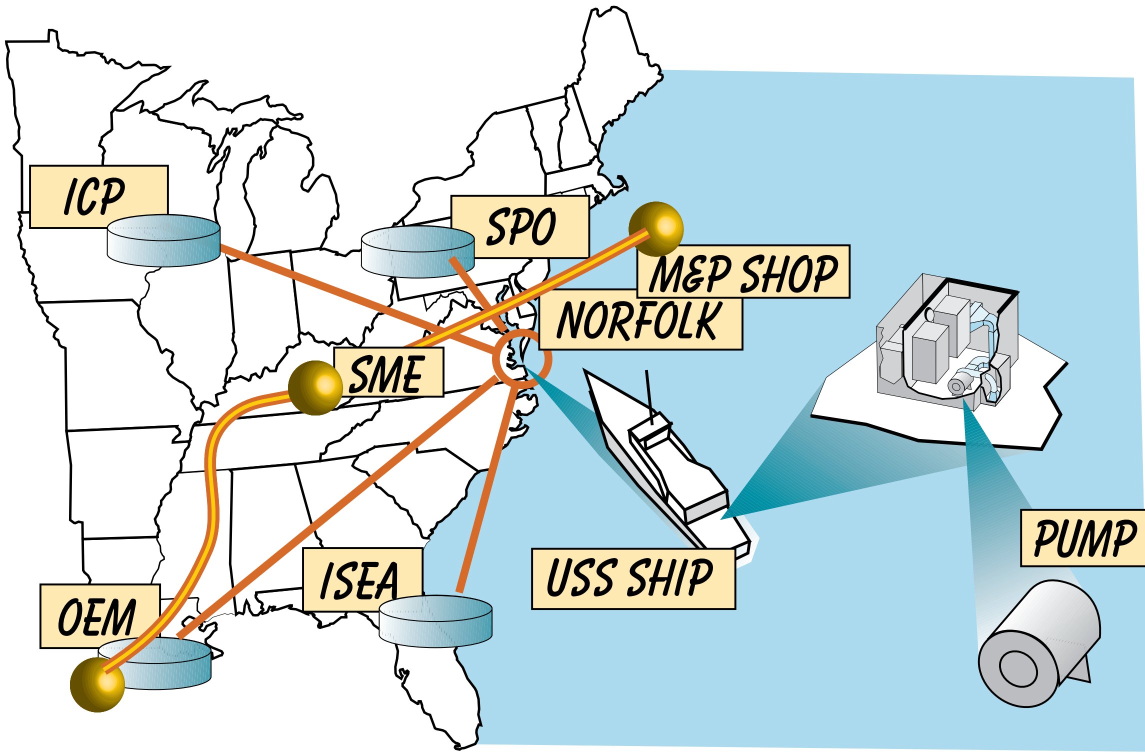
Three years later when the tank technical data maintenance contract is ready for renewal, the program office decides it is in the best interest of the government to consolidate all tracked vehicle technical data maintenance at a single site. Making Tracks Co. (MT) wins the consolidated competition, and tank data management transitions to them. MT will now maintain technical data for use by both government and commercial organizations for all tracked weapon systems.

This scenario depicts a dynamic data maintenance environment wherein all users draw from a common virtual data base (the IDE) comprised of data maintained by any number of government or commercial service providers. So long as information is readily shared by all users, it makes little difference who maintains the data. Readily accessible shared cross-functional information decreases the tendency to form redundant files and thereby reduces inconsistencies associated with asynchronous data.

Scenario 4

In late 1996, budget pressure forced the Navy to transfer an entire class of replenishment ships to the inactive reserve fleet. It is now 1999 and an expanding conflict in the Indian Ocean necessitates that these ships be reactivated to support Fleet operations. Fortunately, prior to their lay-up the ship class technical data was digitized and remains accessible through the IDE.

Public shipyards as well as most private shipyards are fully loaded with battle damage repairs and other work. Because of downsizing throughout the government work force carried out in the mid-90's, and the increased tempo of operations associated with the Indian Ocean crisis, the military and civil service staff available to work the reactivation project is extremely limited. NAVSEA can provide only the program manager, a senior engineer, a logistician, and part time services of a contracts officer to support the effort.



Scenario 4.

In response, the program manager formed a virtual enterprise of small and medium sized businesses led by the small government staff to reactivate the replenishment ships. Along with the mechanical work necessary to get the ships ready for sea, the ships must also be reprovisioned with consumables and repair parts. Reprovisioning appears to be the "long pole in the tent." NAVSEA wants to hold costs down as it is expected the ships will only be needed for 18 months, but initial feedback indicates several critical spares are no longer stocked in the supply system; nor are they available from commercial suppliers. Elroy Jones has been assigned as the government team leader to oversee the reprovisioning process.

Elroy has set up shop in a vacant office at the Puget Sound Naval Shipyard where the ships are in storage. Two local firms have been awarded contracts to reactivate the machinery and combat systems of the ships. Based upon technical information accessed via a temporary network of waterfront terminals with access to the IDE, they are hard at work and so far progress is on track for a 60 day reactivation process. Elroy posted an RFP on the SME (small / medium sized enterprises) bulletin board via the IDE for support services to specify reprovisioning requirements.

Loggies Inc., a small business in San Diego was the successful bidder, and was able to produce a reprovisioning load list in very short order based upon technical data available via the IDE and a provisioning computation algorithm they also accessed via the IDE. Loggies Inc. informed Elroy there are 25 critical repair parts for various mechanical systems that are no longer available from government or commercial sources. They confirmed via their link to the IDE that a complete set of digital product data for each of these parts still exists.

Elroy decides to contact the Electronic Commerce Resource Center (ECRC) in Cleveland to seek help in developing an agile manufacturing solution to his critical spares requirements. Elroy proposes that the ECRC act as integrator of a network of SME agile manufacturers to produce the needed parts. Based upon their experience in working with SMEs, the ECRC took on the task and distributed the production and assembly requirements among a network of 15 SMEs. All worked directly off the digital product data available via the IDE. Production scheduling, work flow management, and transportation were all coordinated via information exchange enabled by the IDE. The parts were ultimately delivered to the ships in time to support the re-activation schedule.

An IDE enables the formation of virtual enterprises made up of specialized organizations that may not have the capability to tackle the entire task themselves, but can do so as a member of a virtual team. In this case it enabled a very small government staff to augment their capabilities through information sharing with small businesses. It also can provide ready access to a broad range of data without the need for laborious research. The agile manufacturing approach was effective because the SME network had seamless access to complete digital product models. The SMEs with their limited individual capabilities and capacities were formed into a virtual production enterprise that provided the "manufacturing muscle" that enabled the ships to deploy on time.

IV IDE OUTCOMES

The IDE is more than a new AIS architecture or business process. It represents a fundamental shift in the role of information in Enterprise operations. This new role will pervade the entire extended Enterprise. It is an element of the cultural change necessary to migrate from static enterprises to a truly dynamic enterprise environment. The following changes describe the transition that will take place as the IDE attains wide-spread participation.

- **Data will be viewed as an Enterprise asset rather than a cost item.** Data generation and maintenance is currently considered a cost item that is outside the scope of revenue generating business processes. For example, detailed parts catalogs and specification sheets are basically "sales" materials, intended to inform OEMs of potential uses for a vendor's product line. As such, they lack the specificity or configuration management of the data for direct use of the OEM's design system and are provided at minimal charge. Under an IDE regime, the electronic equivalents of parts specification catalogs would be useful as an active element of potential buyer's CAD processes and thus would have real value.

- **Assets will be allocated to data maintenance and preservation**. As enterprise data becomes valuable, generators of data (e.g., vendors, service providers) will have a vested interest in maintaining and preserving the highest quality of the data. Product or service providers in a virtual enterprise will sell the associated data along side, but independent from the product or service. Since information will be a shared commodity among a much broader set of users and across a longer/larger segment of the product lifecycle, that informaiton will become a sustainable deliverable with continuing value and maintenance requirements much the same as the wepon system itself. As the cost of enterprise data becomes apparent, IDE participants will find it expedient to invest in maintenance of that data as a means of competitiveness. Vendor selction will be partially based on the quality and accessibility of the associated data over the anticipated lifecycle of the product.

- **Third party enterprise servers will flourish, lowering the cost of traditionally stovepiped business funcitons.** Lifecycle services are normally performed in-house by dedicated departments. In an IDE, those services could easily be exported to third party servers on a continuous or problem-rated basis (Functional Services). For example, an entrepreneurial firm could specialize in end-to-end engineering (reliability, quality, etc.) support from analysis to simulation to testing. OEMs could ocnsider eliminating internal specialty departments in favor of external acquisition of engineering services on an as needed basis (Functional Services). High mobility of enterprise data would facilitate team-based concurrent engineering by remotely based enterprise service providers while the extensive customer base of each server would increase the value of its contribution to a specific project or product line far beyond that which could be maintained internally.

- **Increased specialization will accompany corporate flattening.** Normally, increased corporate specialization results in new or expanded corporate hierarchies as the new specialized departments have to be operated and maintained. The IDE reverses this situation as specialties (such as problem-directed simulation) are exported to enterprise servers. The degree of specialization and intensity of service provided would be determined on a case by case basis rather than the need to "feed" an in-house organizational structure. Corporate flattening would not simply collapse the hierarchy, but rather, concentrate lines of authority around certain "hubs" that correspond to corporate business lines (a primary product or service) and exported services that directly support those lines, rather than organizations - the goal of both total quality and concurrent engineering.

- **Competition will be increased at all phases of product lifecycles.** Currently competition for enterprise products or services (such as spares reprocurement) is restricted to holders of the information needed to support the contracted action. In an IDE, all vendors of products or services to the enterprise (both corporate internal and external) would be subject to greatly increased competition. The free flow of data would enable specialty shops (such as a shared manufacturing center) to be set up on a large scale (e.g., full scale assembly of vehicles) while traditionally full product support corporations could concentrate on core competencies (e.g., design). Increase competition accompanied by concentration on core competencies would reduce cost of products and services.

• **Flattened, core-competency oriented enterprises will feature succinct cycle times and agility.** Corporate structures oriented around core products or services, supported by an extended enterprise of lifecycle services will be extremely agile and able to respond rapidly to market demands. Removal of hierarchies (even flattened ones) and restructuring of the organization around product and competency hubs reduces enterprise communciation to the minimum essential for project completion. Bureaucratic roadblocks are removed.

• **The current gap between ifnrastructure implementors and functional software providers will be bridged.** The IDE provides an essential logical interface between the network builders who are concerned with moving, storing and processing digits in a standard manner, and functional users who need to access network assets to accomplish specialized taskings. Without an IDE, classes of functional users would have to bridge the gap on a case by case basis leading to suboptimized, localized solutions rather than a unified information environment.

V Initial IDE Solutions

Initial IDE solutions are established on an enabling technical infrastructure using the capabilities of JCALS that can then support the implementation of existing business process models and functional requirements. Through JCALS tools, such as the Global Data Management Services (GDMS), information can be accessed from multiple locations, and the user does not have to be concerned about where the data is stored or the format of the data itself. Application of the JCALS Infrastructure includes its GDMS, WFM and Reference Library. When combined with the repository capabilities of the Joint Engineering Data Management & Information Control System (JEDMICS) and the AMC's Commodity Command Standard System (CCSS), these tools form the core of the computing infrastructure's initial solution.

Initial IDE Participants – the Businesses Being Supported

The initial element of the IDE project includes the support of business operations of three PMOs, and one functional support activity, the IMMC. Their business processes cover all elements of the weapon system life cycle environment. Through their pro-active participation in the IDE implementation, they are able to achieve near term operational improvements in their business processes while simultaneously supporting the longer term full scale implementation across the Army weapon system life cycle enterprise.

- PM CMS:

The Project Manager for Combat Mobility Systems (PM CMS) is responsible for the development and fielding of three weapon systems, to include the Improved Recovery Vehicle (Hercules), the

Heavy Assault Bridge (Wolverine) and the Breacher (Grizzly) . The Grizzly and the Wolverine are derivatives of the M1 Abrams tank family and Hercules is a major improvement to the M88 Recovery Vehicle. The two primary U.S. Army tracked combat vehicle producers – United Defense Limited Partners and General Dynamics Land Systems – serve as the prime contractors for the CMS family of vehicles.

- PM JAVELIN

The JAVELIN is a man-portable, anti-tank weapon system designed to provide high lethality against advanced armor. It is comprised of two units, the Command and Launch Unit (CLU) and the disposable launch tube in which the missile is stored. The JAVELIN is unique in ways and takes advantage of several highly technical devices, such as a feature-based tracker and a miniature cyrogenic linear cooler. It can be safely fired from inside a building or room with the recoil or a large back blast and is almost quieter than a machine gun. The JAVELIN weighs 49.2 pounds and has a range of 2000 meters. The JAVELIN is replacing the Dragon missile system. Each of the JAVELIN prime contractors, Texas Instruments (TI) [Dallas, TX] and Lockheed Martin (LM) [Orlando, FL], will potentially be able to share data with the PM JAVELIN through the IDE infrastructure.

- PM MLRS

The MLRS is a multinational free flight artillery rocket system that greatly improves the conventional indirect-fire capability of the field Army. It consists of a self-loading M270 launcher with onboard fire control system, mounted on a highly mobile tracked vehicle. The launcher carries 12 rockets and is capable of firing rockets one at a time or in rapid ripples to ranges beyond 30 kilometers. The M270 launcher is also the launch platform for the Army Tactical Missile System. Each of the MLRS prime contractor locations, Loral Voughts (LV) [Grand Prairie, TX and Camden, AR], will potentially be able to share data with the PM, MLRS through the IDE infrastructure.

- IMMC

The Integrated Materiel Management Center (IMMC) provides wholesale and retail logistics support to all users of Missile Command (MICOM)-managed equipment. To accomplish this mission, the IMMC utilizes the various tools available to the professional logistician to achieve balance in the integrated materiel readiness, requirements determination, engineering and maintenance, rebuild, procurement, disposal, and distribution activities. The IMMC is divided into seven directorates:

1. Sustainment Management (SMD)

2. Air Defense (ADD)

3. Automated Maintenance (AMD)

4. Tactical Missiles (TMD)

5. Business Management (BMD)

6. Logistics Support (LSD)

7. Readiness (RD)

Solution Deployment Template

As the application of the IDE strategy to a specific program or site, each SDS must be a tailored adaptation of the IDE to reflect the data flow requirements of the specific site or program in question. Furthermore, it must be adopted to the technology available at the time of desired deployment. In addition, the SDS will represent a fundamental shift from paper intensive to “paperless”, “digital”, or “interactive” modes of operation. As such, major activities in deployment planning must include the attainment of buy-in from the targeted user base and the capturing and reengineering of user process workflows as templates to be automated on the SDS infrastructure.

This IDE Deployment Template serves as a faramework for weapon system program managers and defense installation managers to plan and manage the deployment of a site-specific SDS of the IDE. Based on experience gained through previous sucessful deployments, this framework identifies all planning, reengineering, acquisiton, and management tasks to be performed to achieve an Initial Operating Capability (IOC) in 18 months. This Template provides a Work Breakdown Structure (WBS), Functional Model, Task Descriptions, and Milestone Chart which together describe an approach that achieves a Preliminary Design Review (PDR) 5 months after initiation and a Critical Design Review (CDR) after 13 months.

The key guiding document in the early stages of the deployment project is the Government Concept of Operations (GCO), which describes the government’s objectives, strategies, and expectations for the SDS. The GCO provides the external community potentially impacted by the SDS (in particular, the current or potential contractor and vendor base) with a statement of the government’s intentions with respect to the SDS. Since this base as well as other field activities may be required to participate in or interact with the SDS, representatives of these communities should participate in the generation of the GCO. This should be done in a Process Action Team environment to meet the 5 month milestone for the PDR.